Quantum interferometry in the time-domain with massive particles

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Mater wave interferometry is a versatile tool for testing the foundations of quantum physics as well as for precision measurements. We have recently developed a universal **O**ptical the **TI**me-domain **MA**ter-wave (**OTIMA**) Talbot-Lau interferometer[1, 2]. It is implemented using three pulsed standing light waves which act as absorptive gratings. Particles traversing the grating antinodes can be selectively removed via ionization or fragmentation.

Three VUV excimer lasers emit light at 157.6 nm with a pulse length of about 6 ns. A single mirror reflects all three laser beams to form three stable and mechanically coupled standing light waves. In our recent experimental realization a pulsed molecular nozzle source (Even Lavie valve) seeds organic molecules into an adiabatically expanding noble gas jet to generate a spectrum of cold clusters which are subjected to the interferometer pulses and detected in a time-of-flight mass spectrometer.

We have performed various experiments with organic clusters to demonstrate the versatility and universal applicability of this new interferometer scheme. It is suitable for nanoparticles that ionize or fragment (i.e. are susceptible to beam depletion) with one or two 157 nm photons. Many types of clusters (metallic, organic, semiconducting), a large range of complex molecules as well as many atomic species are candidates particles for future experiments.

The use of pulsed optical gratings makes it a suitable instrument for high-mass particles which aim at testing the linearity of quantum physics, as well as at probing novel decoherence effects such as fragmentation decoherence or continuous spontaneous localization [5,6].

The instrument opens also new avenues to quantum-enhanced measurements using deflectometry, absorption or photodissociation spectroscopy.

References

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